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Development and Validation of the Digital Literacy Test for Teachers (DigiLiTT)

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Abstract

One essential aspect of literacy that teachers should possess is related to the use of technology. This study aimed to develop a digital literacy test for teachers. The researchers used principal component analysis (exploratory factor analysis) to validate the underlying structure of digital literacy and tested the internal consistency of the instrument using Cronbach's alpha. To gather data, a total of 926 graduating teacher education students from the private and government teacher education institutions in the Cordillera Administrative Region answered a test consisting of 80 alternate response (true-false) items. Statistical analysis confirmed four fundamental components of digital literacy, namely, technical competency, logical proficiency, pedagogical awareness, and moral consciousness. The maximum reliability coefficient is acceptable at 0.807. A 40-item Digital Literacy Test for Teachers (DigiLiTT) is generated in print and online versions.

Introduction

The learning process changes from generation to generation. Teaching strategies that were considered effective in the past may no longer be effective in the present. Differences are related to the evolving characteristics and, eventually, needs of learners. Learners of today are believed to be different in many ways compared to learners of previous generations. Students in the past were known to have operated almost all things manually. In contrast, 21st-century learners, as they are often called, are described as being information and technology savvy. They are especially keen about computing devices, such as cellular phones, video games, digital music players, video cameras, and other toys and tools of the digital age. They are quick to adopt and learn the operation and use of such devices. This distinct trait is believed to have been influenced by an environment that is "media rich, immediate, fast, engaging, dynamic, and instant" (Adair, 2009). Indeed, computing devices are readily available and can be easily afforded by students. Conditions that support the use of these devices, such as internet connection, are likewise widely accessible for use among students. Such is the reason why 21st-century learners are otherwise tagged "digital natives", implying that they are the "native speakers" of the language used for digital devices.

The given condition implies that teachers need to embrace such culture of their learners. As Prensky (2001) puts it, the educational system was not designed for today's students, signifying the strong need for teachers to modify their teaching strategies to suit the needs of learners. However, one major requisite before effecting changes in teaching strategies is that teachers should be able to speak the same language that their learners speak. In other words, teachers should have a certain degree of digital literacy.

Digital literacy, as defined by Casey and Bruce (2010) is the awareness, attitude, and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyze, and synthesize digital resources, construct new knowledge, and create media.

To this day, digital literacy has been well defined. However, instruments that measure digital literacy are limited. In fact, digital literacy tests that are available can only be taken online. This condition restricts the number of examinees to a few, particularly if there are a limited number of computer units and internet connections. Psychometric properties of these online tests (if any) are likewise concealed, making their credibility dubious. Furthermore, no tool that is specifically designed for Philippine conditions has yet been devised to gauge the digital literacy of pre-service teachers.

It is therefore the goal of this study to develop a digital literacy test for pre-service teachers with duly established psychometric properties. DigiLiTT is envisioned to accurately assess the level of digital literacy among students enrolled in teacher education institutions. While the conventional pedagogy of learning still exists, it could be noted that learning theories for the digital age are introduced by modern educational scholars, making the tasks of the teachers even more challenging (Sicat, 2015).

This study primarily aimed to develop a 50-item digital literacy test for pre-service teachers. Part of the objectives of this study was to establish the psychometric properties of the DigiLiTT, particularly its reliability and construct validity. Determining the digital literacy among pre-service teachers was only a secondary objective of this study. Specifically, it sought the answers to the following: 1) the reliability coefficient of the DigiLiTT; and 2) the underlying structures of the DigiLiTT.

DigiLiTT was specifically designed only for students enrolled in teacher education programs, i.e., Bachelor of Elementary Education and Bachelor of Secondary Education. The instrument may be used across year levels and fields of specialization. However, in view of the tool's pedagogical aspect, DigiLiTT will not cover other degree programs outside teacher education. DigiLiTT is particularly intended for students in urban and suburban communities where there are vast digital resources. Results may not be as accurate if taken by pre-service teachers in rural communities. Out of the 80 items in the DigiLiTT, 76 were included in factor analysis; 4 items were excluded as these items did not contribute to the reliability of the entire test. The scree plot was used to determine the number of factors to be extracted. There were four points to the left of the point of inflexion in the scree plot. Thus, four factors were extracted. Confirmatory factor analysis (principal component analysis) was employed to identify the grouping or clustering of the variables. Orthogonal rotation (varimax) with Kaiser normalization was the rotation method specified. Meanwhile, Cronbach's alpha (α) was used for the reliability analysis. In performing the procedure, only the 76 items of the DigiLiTT were included. Parametric statistics (independent samples *t*-test and one-way analysis of variance) were used to test the hypotheses at a level of significance set at α=.05.

Literacy was described as a stable group of skills; however, it is important to emphasize that these literacy skills are not transversal to different contexts and times (Baleiro, 2011). As for educational setting, it is defined as a set of multi-faceted social practices that are shaped by contexts, participants, and technologies (National Council of the Teachers of English, 2011). DigiLiTT narrows down to focusing more on digital literacy, as supported by Newrly and Veugelers (2009), stating that digital literacy has become one of the main competencies in the 21st century.

Digital literacy, as introduced by Gilster (1997), in his book bearing the same title, is explained generally as "the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers." Corollary, it is the ability to appraise data by establishing the connection of interrelated pieces to form useful information. Thus, digital l iteracy requires the ability to utilize computers to fulfill the needed demand for information in the appropriate situation. Digital literacy, as used by authors Lanham (1995), Bawden (2001), and Eshet-Alkalai (2004), among others, as compared by Lanshear and Knobel (2008), develops as it is influenced by the technological development, at thetime available. Evidently in 2006, the European Framework for Digital Literacy recognized the definition of digital literacy as the "awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyze and

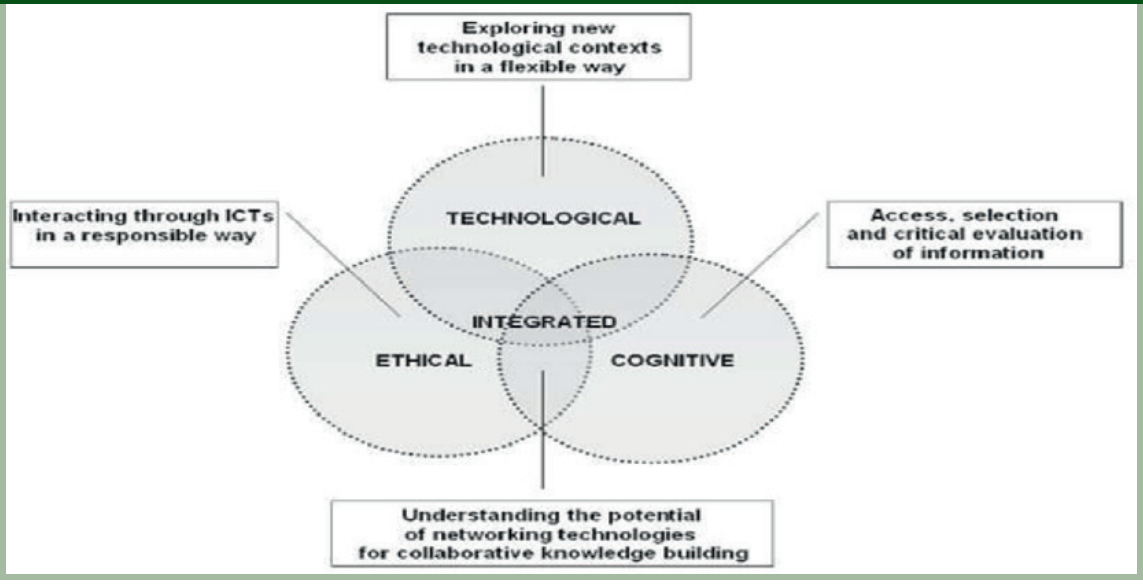
synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, to enable constructive social action; and to reflect upon this process" (Martin & Madigan, 2006). Gillen and Barton (2010) summed it up when they stated that digital literacy is interlinked with the ability to read and write text, manipulate and interpret numbers, handle and understand various mechanical devices, and use and understand a range of IT hardware, software, new forms of data representations, and the interface between them. They also emphasized the ability to connect and link these abilities to meet the changing educational needs and practices. Consistent with the foregoing definitions, Ranieri et al. (2017) highlighted the importance of digital literacy for future teachers, citing the research of Gudmundsdottir et al. (2014) and Lund et al. (2014), who found a mismatch between actual digital challenges and the students' academic training. The study was able to recommend how to incorporate digital and media literacy activities in a teacher professional development program to address digital challenges.

A comprehensive model of digital literacy is proposed by Calvani et al. (2009), comprising three dimensions, namely technological, cognitive, and ethical (Figure 1). The technological dimension of digital literacy relates to the ability to properly use and operate computer-aided devices. Cognitive dimension refers to the ability to access, select, and critically evaluate information. The ethical dimension pertains to the ability to interact using ICTs with a sense of responsibility. Essentially, the integration among these three dimensions defines digital literacy. Specifically for teachers, the pedagogical aspect of digital literacy also plays an important role. The pedagogy aspect deals with the utilization and incorporation of computer-operated devices in teaching.

In the DigEuLit three-level model of digital competence, the highest level involves creativity and innovation. Specifically, this refers to the ability to stimulate significant change within the professional or knowledge domain (Ferrari, 2012). However, in the digital competence model of Calvani et al. (2009), the cognitive dimension involves being able to read, select, interpret, and evaluate data and information, considering their pertinence and reliability. In the analysis of frameworks done by Ferrari in 2012, she identified seven dimensions of digital competence, which include evaluation and problem-solving. Accordingly, it is understood in more than one case study as the identification of the right technology and media to solve the identified problem or to complete a task, and also as the assessment of information retrieved or the media product consulted.

Figure 1

Digital Competence Model. (Calvani et al., 2009)



Another cognitive dimension of digital literacy would be "lateral literacy," as cited in the study of Eshet-Alkalai (2004). Accordingly, besides improving people's performance with computer programs, hypermedia technology introduced computer users to new dimensions of thinking and new challenges of digital literacy, which are necessary to make an educated use of this elaborate technology. From an educational perspective, the major importance of the hypermedia-based environments is not so much the multitasking work they allow the user, but the ability to use these environments for navigating laterally, in a non-linear way, through knowledge domains. This capability enhances lateral, multi-dimensional thinking, and has led to the evolution of a new kind of digital literacy – 'lateral literacy'. Rouet and Levonen (1996), as cited by the same author, suggested that this technology helps learners to move away from linear thinking into rich-associative lateral thinking. According to them, in order to perform demanding multi-level tasks, learners must be able to think laterally and synthesize knowledge from pieces of information that are collected in different, sometimes independent, domains of knowledge.

Meanwhile, Ng (2012), as cited by Ifenthaler and Hanewald (2014), associated the cognitive dimension of digital literacy with the ability to think critically in the search-evaluate-create cycle of handling digital information. Accordingly, it means being innovative with technology, that is, being able to assess, select, and re-purpose appropriate software programs for educational purposes. In the same author's explanation though, ethical and legal issues were included in cognitive dimension such as being knowledgeable about ethical, moral and legal issues associated with both on-line and offline digital technologies as well as the understanding of multi-literacies (The New London Group, 1996) that involves the ability to decode information that are text-based and information from images, sound bytes, videos, maps and models. Eshet-Alkalai (2004) made use of the term Information literacy to refer to the cognitive skills that consumers use to evaluate information in an educated and effective manner. Information literacy works as a filter: it identifies erroneous, irrelevant, or biased information and prevents its infiltration into the learner's system of considerations (Gilster, 1997; Minkel, 2000). The author added that Information-literate people think critically and are always ready to doubt the quality of information. They are not tempted to take information for granted, even when it seems "authoritative" and valid.

Internet Keep Safe Coalition (2009) explained that cyber-ethics involves the ability to recognize and practice responsible and appropriate use while accessing, using, collaborating, and creating technology, technology systems, digital media, and information technology. Further, the ability to demonstrate an understanding of current ethical and legal standards, the rights and restrictions that govern technology, technology systems, digital media, and information technology within the context of today's society. Specifically, students will understand and follow acceptable polices (school, home and community), and understand the personal and societal consequences of inappropriate use; demonstrate and advocate for ethical and legal behaviors among peers, family, and community; practice citing sources of text and digital information and make informed decisions about the most appropriate methods for avoiding plagiarism; make ethical and legal decisions while using technology, technology systems, digital media and information technology when confronted with usage dilemmas; exhibit responsibility and netiquette when communicating digitally; recognize the signs and emotional effects, the legal consequences and effective solutions for cyberbullying; recognize appropriate time and place to use digital tools, techniques and resources; understand the importance of online identity management and monitoring; and advocate others to understand the importance of Online Reputation Management.

In Ferrari's model of digital competence (2012), the ethical dimensions are captured under Communication and Ethics and Responsibility. Communication refers to the KAS (knowledge, attitude, skills) for communicating through online tools, considering privacy, safety, and netiquette. Ethics and responsibility are understood as the knowledge, attitudes, and skills needed to behave in an ethical and responsible way, aware of legal frameworks. Meanwhile, Ng (2012), as cited by Ifenthaler and Hanewald (2014), described this dimension as socio-emotional. It means adopting the right attitudes and being able to use the internet responsibly for communicating, socializing, and learning, as well as being able to protect oneself from adversity associated with online presence, such as cyberbullying or personal information theft.

The UNESCO ICT competency framework for teachers (as cited by Ferrari, 2012), also foresees elements of technical operations. The framework is not about digital competence per se, but rather suggests entrenching ICT in every aspect of educational institutions, from policy to pedagogy to administration, thus proposing an innovative approach to using technologies in education. In module four of the framework, the basic technology literacy expected of teachers is based on an application-oriented approach, at least at basic level: 12 uses of common hardware technologies; basic tasks and uses of word processors; basic features of presentation software; basic function of graphic software; use of the Internet; use of a search engine to do a keyword Boolean search; creation and use of an email account; function and purpose of tutorial and drill and practice software; location and evaluation of educational software packages and Web resources; use of networked record keeping software; use of common communication and collaboration technologies, such as text messaging, video conferencing, and web-based collaboration and social environments. However, Ferrari added that the foregoing is only a basic part of the ICT competence being referred to by UNESCO. The latter viewed it in a wider spectrum with the integration of its pedagogical perspective, like when and how to use ICT in classroom activities.

The foregoing frameworks provided the basis for the development of the tool. The items were anchored on the various dimensions as identified. The Digital Competence Framework by Calvani et al. (2009) illustrated a multidimensional perspective of digital competence, which includes technological, ethical, and cognitive. This was the main basis of the conceptual framework of this study. The UNESCO ICT framework for teachers emphasized the pedagogical dimension together with the other dimensions present in Calvani's. Anusca Ferrari's framework reinforced ethics with dimensions on digital safety and responsibility.

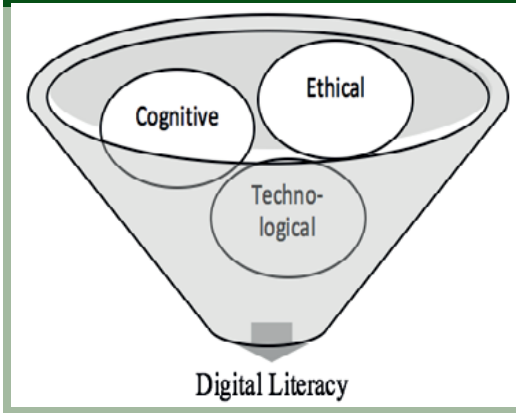
This research is very important in addressing the challenges faced by teachers in teaching millennials. Specifically, the output of this study is a tool to evaluate how pre-service teachers use technology and digital media strategically and capably, providing TEIs with an idea of how to digitally equip their learners so that they will be ready for the challenges in the field. Learners will also be allowed to assess themselves on how digital learning is helping them learn, as well as evaluate themselves on what and how digitally made equipment and devices "control" their learning. Administrators will also be given a picture of the importance of technology and digital media equipment and devices to the lives of learners, helping them design the trainings and workshops they plan to provide their teachers. Finally, teachers will benefit from this study, especially in making teaching become highly engaging and to be able to delivering the kind of instruction that the learners truly deserve.

The conceptual framework of this study was guided by the review of relevant literature and the results of related previously conducted studies. This study purported that digital literacy is determined by three aspects, namely technological, cognitive, and ethical (Figure 2). The technological aspect of digital literacy defines the skill of teachers to manipulate products of technology, especially those used inside the classroom. The cognitive aspect indicates the ability of teachers to select and make sense of information, particularly the products of technology. The ethical aspect of digital literacy denotes the propensity of teachers to use technology responsibly, considering the moral and legal implications of the use of information. A test that will correctly describe the digital literacy of teachers should consist of items of all three aspects. This is to say that digital literacy of teachers should be described in terms of technological skills, cognitive ability, and a sense of responsibility.

Conceptual Framework

Figure 2

Conceptual Framework of the Study



Methodology

Research Design

The developmental research design was employed. This study primarily aimed to develop a 50-item Digital Literacy Test for Pre-Service Teachers (DigiLiTT) with well-established psychometric properties. As such, it operated on the procedures for developmental research, including item writing, pilot testing, and evaluation of the test. The study was conducted in private and government teacher education institutions in the Cordilleras. This area has been selected to enable a localized digital test for teachers. Most of the TEIs in this region are located in the central business district, which is highly urbanized. In these communities, digital devices are readily available and accessible to students, and their use in various settings, including the classroom, is supported.

Population of the Study

The DigiLiTT was administered to 926 pre-service teachers who had just completed their teaching internship, whose ages range mostly from 19 to 21 years old, from various TEIs in the Cordillera Administrative Region. Total enumeration was employed. There was very little difference in the number of respondents when classified according to the type of school they were enrolled in. The table shows that 485 of the 926 respondents are studying in a public school/ state university, while 441 are in a private college/ university.

In terms of degree, the respondents indicated Bachelor of Secondary Education (560), Elementary Education (319), Professional Education (those who took 18 units of Professional Education courses, 18), and a few (20) missed to indicate it. Meanwhile, most of the respondents from Bachelor Secondary Education were specializing in English (142), followed by Technology in Livelihood Education (83), Math and MAPEH (74), Social Studies (55), Biological Science (33), Filipino (29), Physical Science (4), Values Education (3), and General Science (2), respectively. Among those from the Bachelor of Elementary Education, most were specializing in General Education (139), followed by Special Education (51), and Early Childhood Education (37), respectively. The rest were composed of those taking Professional Education (17), and 183 failed to indicate their field of specialization.

Research Instruments

Data were gathered by way of a test which was composed of two parts. The first part asked for the demographic profile of the respondents. The second part contained the Digital Literacy Test for Teachers (DigiLiTT). The DigiLiTT is composed of 80 alternate response (true-false) items based on a table of specifications. The test items represent four components, namely, cognitive, ethical, technological, and pedagogical. The first three components were adopted from literature, while the fourth (pedagogical) was added by the researchers to enable the accomplishment of the study's main goal of developing a digital literacy test specially designed for pre-service teachers.

Data Gathering Procedure

Permission was sought from the heads of the participating TEIs before data collection was done. Initially, a test composed of 80 multiple-choice questions with four choices was drafted based on the conceptual framework. Pilot testing to test clarity, reliability, and timing was done with 500 pre-service teachers, ensuring uniform data collection protocols, including ethical considerations for respondents as specified in the informed consent. The items were revised based on the pilot feedback. Further, the test was subjected to content validity by four experts who have been practicing in their field of specialization for more than ten years. These fields include Information Technology, Educational Technology, Educational Assessment, and Psychological Testing. Revision was done based on the experts' comments and suggestions. The revised version of the Digital Literacy Test was administered to all fourth-year college students who had just completed their teaching internship from all TEIs in the Cordillera Administrative Region. An informed consent form was explained and given to each participant to ensure they understood the purpose of the study, procedures involved, risks, and potential benefits, and alternative options, including their right to decline. To ensure data integrity, consistency, and minimal bias, quality control measures were observed during the data collection. An orientation for all the test administrators was done beforehand to provide standardized instructions for participants during the data gathering. Distractions and noise

were minimized to allow for focus while the respondents were answering the test. Forty to fifty minutes were given for the respondents to complete the test.

Data Analysis

Data were then tallied, summarized, and subjected to statistical analysis. The Statistical Package for the Social Sciences (SPSS) or Predictive Analytics Software (PASW) was used for this purpose. Specifically, data were summarized using descriptive statistics: frequency, percent, mean, and standard deviation. Preliminary analysis was performed before the extraction of factors. Data screening, assumption testing, and sampling adequacy were done.

Factor analysis can only be done when variables (items) correlate well. In fact, Field (2009) recommended the elimination of items that correlate with no others. The univariate descriptive option produced a correlation matrix (R-matrix) where the top half shows the Pearson correlation coefficients between all pairs of items and the bottom half reveals the one-tailed significance of these coefficients. The R-matrix reveals that the r-values range from a low of rmin = - 0.12 to a high of rmax = 1.00. Most of the probabilities associated with the r-values are less than the alpha level (α=0.05), which means that the majority of the relationships between variables are significant.

Part of the diagnostic analysis performed is the determination of the reliability coefficient of the test, including the identification of the contribution of each item to the reliability of the instrument. Test for internal consistency of the test (Cronbach's alpha) revealed that the minimum reliability coefficient of the instrument is 0.803, considering all 80 items. The maximum reliability coefficient was recorded at 0.807 after four items were deleted.

Meanwhile, Table 1 presents the results of the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. The KMO statistic obtained is 0.774. With this, it can be surmised that the sample is good (Hutcheson & Sofroniou, 1999, as cited by Field, 2009) and is sufficient to be subjected to factor analysis. According to Kaiser (1970), a bare minimum of KMO = 0.5 is needed to be confident that the sample size is adequate for factor analysis, and a value between 0.8 and 0.9 is considered great.

The obtained approximate chi-square value for Bartlett's test of sphericity is 9469.722 with a degree of freedom of 2850. The probability associated with the computed value is p = 0.00, which is less than alpha ($p<0.05$); thus, the test is significant. The result means that the R-matrix is not an identity matrix, and that there are some relationships between the variables to be included in the analysis. Therefore, factor analysis is appropriate.

The scree plot was used to determine the number of factors to be extracted. Figure 3 presents the scree plot generated from the data. The figure shows that the point of inflexion is at the fourth data point. This confirms that there are four factors to be extracted. Exploratory factor analysis (principal component analysis) was employed to identify the grouping or clustering of the variables. Orthogonal rotation (varimax) with Kaiser normalization was the rotation method specified.

Table 1

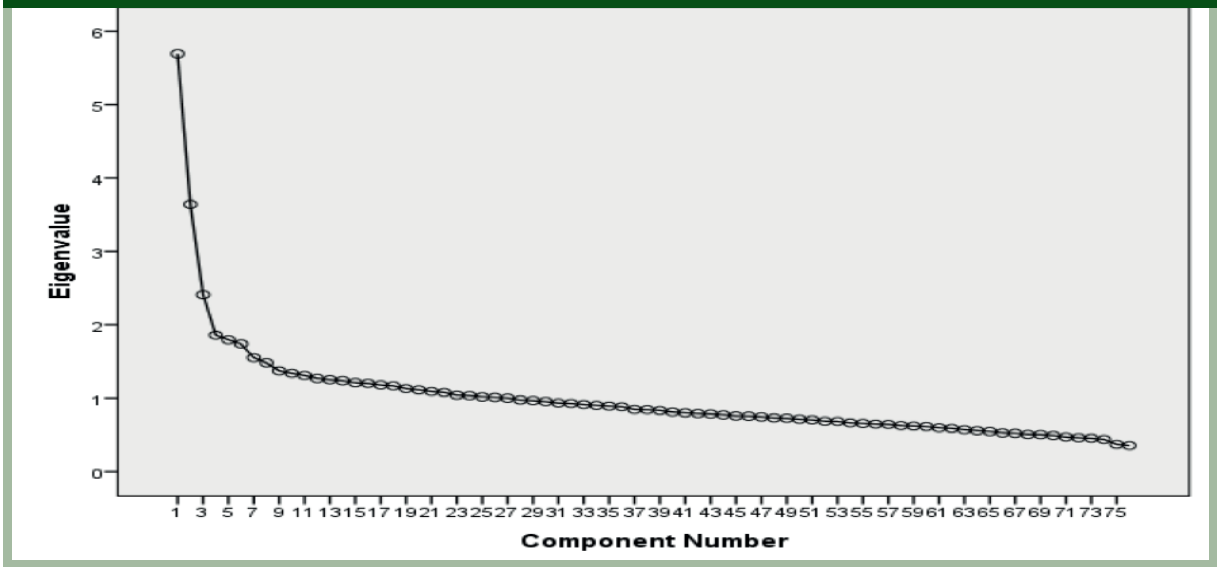
Results of the Kaiser-Meyer-Olkin (KMO) and Bartlett's Test

Test	Computed Value	Degree of Freedom	Significance
Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy	0.774	-	-
Bartlett's Test of Sphericity	9469.722[a]	2850	0.00

a-approximate chi-square value

Figure 3

Scree Plot Graphing Each Eigenvalues Against the Factor with which it is Associated



Results and Discussion

Reliability Analysis of the Items in the DigiLiTT

Reliability means that a measure (or in this case questionnaire) should consistently reflect the construct that it is measuring (Field, 2009). Cronbach's alpha (α) was employed to all the 80 items of the Digital Literacy Test for Teachers. Table 2 presents the reliability statistics. The table shows that the initial reliability of the test is α=0.803. Item-total statistics was further analyzed. The item-total statistics show the values of the overall alpha if the corresponding item was not included in the calculation. Three items were found to increase the internal consistency of the test if deleted. For the second run, 77 items were tested raising the reliability coefficient to α = 0.806. A look at the resulting item-total statistics recommended that one item was deleted to increase the internal consistency. For the third run, 76 items were tested that improved the reliability coefficient to α= 0.807. Resulting item-total statistics suggest that none of the 76 items would substantially affect reliability if they were deleted. The reliability coefficient has reached the maximum; thus, this was the final run of test performed. Values that indicate good reliability are between 0.7 and 0.8 or thereabouts. Therefore, the alpha obtained for the DigiLiTT implies that the scale has a reputable reliability.

Factors of the DigiLiTT

Table 3 shows the factor loadings of the four dimensions of the DigiLiTT after rotation. Component 1 has factor loadings that range from 0.210 to 0.545; the factor loading of component 2 range from 0.180 to 0.432; factor loadings of component 3 range from 0.236 to 0.696; and component 4 has factor loadings from 0.183 to 0.559. The items that cluster on the same components suggest that component 1 represents technical competency (28 items); component 2, logical proficiency (28 items); component 3, pedagogical awareness (10 items); and component 4, moral consciousness (10 items).

Table 2

Reliability Statistics Showing Cronbach's Alpha

Run	Number of Items	Cronbach's Alpha
Initial	80	0.803
2nd	77	0.806
3rd	76	0.807

Table 3

Summary of the Factor Loadings of the Four Dimensions of the DigiLiTT

Dimensions	Factor Loadings	
	Min	Max
Technical Competency	0.210	0.545
Logical Proficiency	0.180	0.432
Pedagogical Awareness	0.236	0.696
Moral Consciousness	0.183	0.559

The first dimension relates to technical competency. Items that cluster to this component relate to manipulation of devices and online and offline applications. The statistical result confirms that digital literacy necessitates technical competency among teachers. Considering the items that were classified under this component, technical competency is therefore defined as the ability of teachers to properly use computer-aided hardware and software devices and other products of technology online and offline, especially those that are being used in the classroom.

The result implies that the know-how in operating computers and computer-aided technologies inclusive of the hardware and software is a basic and essential competency for the digital literacy of a teacher. The ability to manipulate both traditional and contemporary technologies give teachers more options and eventually more chances of using the best-suited tool for a particular subject or content, group of students and learning situation. With this, they will be able to provide the utmost possible opportunities for maximum student learning. At the same time, teachers also expand knowledge and skills in many other areas not necessarily in their own field as they venture into the numerous learning opportunities the internet provides. Further, knowing how to basically use these modern technologies lays the foundation knowledge and skills including confidence that will help in advancing one's technical competence in handling the emerging and more advanced technologies that are being and yet to be developed.

This is in consonance with the UNESCO ICT competency framework for teachers (as cited by Ferrari, 2012), basic technology literacy expected of teachers is based on an application-oriented approach. This includes at least at basic level: 12 uses of common hardware technologies; basic tasks and uses of word processors; basic features of presentation software; basic function of graphic software; use of the Internet; use of a search engine to do a keyword Boolean search; creation and use of an email account; function and purpose of tutorial and drill and practice software; location and evaluation of educational software packages and Web resources; use of networked record keeping software; use of common communication and collaboration technologies, such as text messaging, video conferencing, and web-based collaboration and social environments.

Another component that defines digital literacy relates to the cognitive aspect. Logical proficiency indicates the ability of teachers to select and make sense of information, particularly the products of technology. Items that cluster in the logical proficiency component include the sound and coherent utilization of devices, software and applications in various ways. Sample items in the logical proficiency component are: use the PowerPoint presentation as a detailed reference for students, and one advantage of searching online is the reliability of sources.

The occurrence of logical proficiency as a component of digital literacy suggests that it is not enough for teachers to know how to operate a technological device, rather they should be able to use it rationally. That is, one utilizes a particular technology appropriately, practically and purposefully. Compared with the theoretical basis of this study like that of Calvani and associates which used 'cognitive', logical proficiency is used to provide clarity in such a way that the term is more descriptive and representative of the items that make up the said dimension.

This result can be ascribed to the reason that the use of technology has to make sense. It has to serve its purpose as a tool or machine that makes life easier yet more productive. Using the same lens in the case of teaching and learning process, it has to simultaneously facilitate the delivery of instruction by the teacher and make the process of learning by the students simpler

yet greater. To achieve this, a teacher who is digitally literate should be able to make sensible use of technology in teaching to give justice to the very reason why such a technology was developed.

Calvani et al. (2009) validate this result with their proposed comprehensive model of digital competence which is composed of ethical, cognitive and technological dimensions. Particularly, they explain that cognitive dimension involves being able to read, select, interpret, and evaluate data and information taking into account their pertinence and reliability. Further, in the study of Eshet-Alkalai (2004), another cognitive dimension of digital literacy was cited. It is called "lateral literacy" which was explained that besides improving people's performance with computer programs, the hypermedia technology introduced computer users with new dimensions of thinking and new challenges of digital literacy, that are necessary in order to make an educated use of this elaborate technology.

Statistical results also confirm that digital literacy involves its application in teaching. Pedagogical awareness is another component that defines digital literacy among teachers. Pedagogical awareness refers to the appropriate, responsible and efficient utilization and integration of computers and computer related devices in teaching. Pedagogical awareness concerns the proper use of computer-related hardware and software in teaching and learning in such a way that the goals of learning are achieved. It also relates to the accountable integration of the said technologies in teaching whereby the students' well-being is protected in both online and offline platforms. Finally, this dimension has something to do with enabling the teachers and students achieve the desired results with little or no waste of time or resource materials. Some items included are: personal computers help carry out routine tasks in the classroom like the preparation of instructional materials; view the entire video before using it in class; and use appropriate and transition for multimedia materials.

It can be inferred from this result that teachers have to possess the capability of using computer-related technologies in teaching in such a way that the students acquire the necessary knowledge and skills as required in the course and degree that they are pursuing. Without the integration of evidence-based principles and theories in teaching and learning, using technologies will just be merely using a new tool without realizing the best potential benefit of it to teaching. Hence, teachers should be capacitated in utilizing technology efficiently to facilitate the learning of required knowledge and skills by the students. In-service trainings of teachers should include trainings that would introduce, develop and update their knowledge in integrating technology in teaching since the evolution of technologies is at exponential pace. With this, there will be better chances in achieving the goals of Education 4.0 to produce graduates or professionals who would be able to work in partnership with various technologies to create new possibilities in industries and in other fields including education.

This result can be credited to the fact that even the use of technology has to be contextualized accordingly. It is not enough to use a technology correctly based on its technical aspect. More so, it is incorrect to use a particular technology in the classroom only because it is trending or worst because it is the only available technology in the school. In the classroom it has to be used according to the learning goals. A teacher who is pedagogically aware chooses the technology or technologies that would best achieve the learning goals. Various learning conditions and principles that has to do with integrating technology in teaching is also considered. Therefore, pedagogical awareness is a necessary dimension of a teacher's digital literacy. This result is supported by Ferrari (2012) as he explained that the ICT competency for teachers as identified by UNESCO should not only include basic ICT competence but also pedagogical perspectives like when and how to use ICT in the classroom. This also agree with the TPACK framework by Mishra and Koehler where pedagogical knowledge forms part of teachers' competence in integrating technology in their lessons

The fourth aspect of digital literacy manifests in the way by which technology is applied. Thus, the dimension moral consciousness. Moral consciousness denotes the propensity of teachers in conscientiously using technology in the classroom considering the relevant ethical and legal implications. Included in the moral consciousness component are: online integrity; upholding of intellectual property rights; personal e-safety precautions; and respect and concern towards others. This term is used to name this dimension instead of 'ethical' or other terms to better describe and encapsulate the constituting items.

Table 4

Distribution of Items in the DigiLiTT

Topics	Items in the TOS	Possible Items for the Inclusions*	Items for Inclusion in the DigiLiTT
Technical Competency	10	14,20,21,24,40,42,43,33,45,46, 48,40,50,54,55,57,58,59,60,61, 64,66,67,68,71,75,77,79	20,42,44,44,48, 49,54,55,66,77
Logical Proficiency	10	7,9,12,13,15,16,18,22,25,26, 27,28,29,31,38,39,41,47,51,56, 63,65,69,70,72,76,78,80	9,16,18,25,26, 27,29, 31,39, 78
Pedagogical Awareness	10	17,30,32,33,34, 35,36,53,62,73	17, 30, 32, 33, 34, 35, 36, 53, 62, 73,
Moral Consciousness	10	1,2,3,4,5, 6,8,10,11,19	1, 2, 3, 4, 5, 6, 8, 10, 11, 19
Total	40	76	40

** - Items in bold print are for item banking*

It also makes clear that the dimension is about the responsiveness of teachers in relation to the moral aspects of technology utilization and integration in teaching.

This result suggests that teachers' digital literacy needs to be broad enough to include not only the hard skills in using ICT or computer-related technologies but also the soft skills. They have to be aware of the possible areas and concerns of e-safety so that they can inform and help safeguard their students from possible threats. They have to know e-safety precautions including interventions to online threats. Likewise, they have to model a sense of propriety and respect to others online, whether in their professional or personal social networking accounts. Moreover, they should take the lead in upholding intellectual property rights and other ethical implications in using ICT in general. With these in mind, school heads or managers need to include in-service trainings to equip teachers with these skills. Meanwhile, it also indicates that students from all fields not only in teaching need to be taught of the basic hard skills in using ICT as well as the soft skills particularly the moral implications of using ICT and dealing with online information.

The emergence of moral consciousness as a dimension of teachers' digital literacy can be ascribed to the numerous cases related to online safety of various internet users most specially the young ones who are actively involved online. Some of these include computer-related identity theft, online libel, online scam, anti-photo and video voyeurism, threat, system interference or hacking, illegal access, ATM or credit card fraud, violation of intellectual property rights and others. We can see these things happening as being reported from the news if not in our own neighborhood or workplaces, or even in our own families. All of these acts have something to do with the violator's moral consciousness in relation to doing online activities.

From another point of view, the dimension on moral consciousness can also be attributed to the fact that every privilege is packed with a responsibility that works as a control mechanism. With these, they become more efficient whether in work-related tasks or personal tasks. Thus, these tools can be considered a privilege to man accompanied by responsibilities and accountabilities that serve as control mechanisms to avoid misuse and abuse.

This result is supported by Ferrari's model of digital competence (2012) where the moral dimension is captured under Communication and Ethics and Responsibilities. This also coincided with Ng's socio-emotional dimension (2012) and Eshet-Alkalai's (2004) socio-emotional literacy as one aspect of digital literacy. Accordingly, socially-literate users of the cyberspace know how to avoid "traps" as well as derive benefits from the advantages of digital communication.

The result of the statistical analysis performed on the Digital Literacy Test for Teachers is summarized in Table 4. The target of this research is to produce a 40-item test that would gauge the digital literacy of teachers. A table of specifications was designed, which specifies four components of digital literacy as supported by literature, namely technical, cognitive, pedagogical, and ethical. An item pool consisting of 80 alternate response (true-false) questions was constructed and subjected to psychometric testing to include reliability test and factor analysis. Test for internal consistency using Cronbach's alpha recommended four items for deletion to obtain maximum reliability coefficient. A total of 76 items were subjected for confirmatory factor analysis. Principal component analysis performed on the data confirmed four components that define digital literacy for teachers, which were renamed as Technical Competency (k=28), Logical Proficiency (k=28), Pedagogical Awareness (k=10), and Moral Consciousness (k=10). To conform with the TOS, items were selected for inclusion in the 40-item Digital Literacy Test for Teachers and the rest are reserved for item banking.

The educational significance of these results lies in its contribution to strengthening the preparation of student teachers in the digital age. As digital literacy becomes a core competency for educators, the study underscores the need for pre-service teachers to acquire technical competency, logical proficiency, pedagogical awareness, and moral consciousness required to effectively integrate information and communication technology (ICT) in their future classrooms. By examining the level of digital literacy among pre-service teachers, the tool can provide insights that can inform teacher education institutions on how to improve pedagogical practices and design curricula that are aligned with the Philippine Professional Standards for Teachers (PPST) and international benchmarks. Moreover, the study highlights the role of digital literacy in promoting lifelong learning and professional growth, enabling future teachers to continuously adapt to emerging technologies and use them to enhance teaching and learning. The findings also emphasize the importance of equipping pre-service teachers with the capacity to foster inclusive and equitable education, ensuring that technology integration benefits diverse learners, including those in marginalized or underserved contexts. Ultimately, the study contributes to the broader goal of preparing student teachers to be effective, future-ready educators who can empower their learners through innovative and meaningful technology use.

Conclusions

The basic framework of the Digital Literacy Test for Teachers (DiGiLiTT) are Technical Competency, Logical Proficiency, Pedagogical Awareness and Moral Consciousness. The reliability coefficient (internal consistency) of the instrument is acceptable. Digital literacy is not only defined by a person's ability to technically operate digital tools, but includes appropriate pedagogical and ethical use. Educators of teacher education programs will be able to gauge the digital literacy of the pre-service teachers through the developed tool so that they can tailor-fit their instruction based on the results. In general, the results of the study imply the need to teach pre-service teachers, not only the technical and logical aspects of using technology in teaching but also the pedagogical and moral dimensions. Hence, making digital literacy teaching holistic. The tool can be refined through further studies in relation to expert/content validation and culture bias.

Recommendations

Based on the findings, the following suggestions are made. First, subject the four components of the Digital Literacy Test for Teachers to the analysis of its internal consistency to ensure that the items for each construct yield similar results. Second, test the instrument for culture bias to increase reliability, make the test more inclusive and avoid cultural aspects that affecting the validity of the test. Third, assess the Digital Literacy of Teacher Education students based on the four identified underlying factors and support the result with qualitative descriptions to make it more comprehensive. Fourth, consider the use of DigiLiTT in gauging the digital literacy of students enrolled in the various TEIs and degree programs to support possible revision of technology and pedagogy-related courses in the Teacher Education Curriculum. Last, advocate for test development appropriate for our culture to enable more valid and reliable results.

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